PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES
FOURTH SERIES

Vol. XXXVI, No. 11, pp. 317–346; 2 figs.; 3 pls. April 10, 1969

OBSERVATIONS ON THE VIZCAÍNO DESERT AND ITS BIOTA

By

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Gerhard and Gulick (1962, preface) pointed out that many books dealing with the peninsula of Baja California have appeared, the first in 1771, and that one could get a great deal of information about the region from the resources of a good library. They wrote further, "In spite of all this, Lower California for some reason has become endowed in recent years with an aura of mystery, and much misinformation has been published about it." Their book, with its reprintings and revisions, has done much to correct some of the misconceptions about Baja California. It contains the most reliable data available about roads, ranchos, towns, villages, mines, and distances from one to another of them to be found in any publication.

In contrast, as late as 1905 there were few maps of Baja California that could give a prospective traveler any information, and still fewer that were reliable. E. W. Nelson, writing 15 years after a year-long saddle and pack trip the length of the peninsula (1921, p. 12) wrote, "Through the lack of designations for numerous geographic features, I have thought it advisable to propose names for them. The names are mainly those of some of the early Spanish explorers and missionaries, who first made known the coasts and interior of the peninsula, and of certain American naturalists, whose scientific work has given us much of our information concerning the wild life of this region." He then listed nine peaks and four plains to which he had given names, one of these was "Vizcaíno Desert, in honor of the navigator Sebastian Vizcaíno."

Nelson delimited the Vizcaíno Desert as follows: "A broad and largely sandy plain, which may be called the Vizcaíno Desert, begins on the Pacific coast a little south of Santa Rosalia Bay and extends southeasterly about 150 miles to a

point on the coast southeast of Ballenas Bay. On the northern and eastern sides it is limited by the foothills and lower slopes of the great interior plateau. This plain is broadest opposite Scammon Lagoon, where it reaches a width of about 60 miles, and narrows to a point at both ends. It is the largest comparatively level area in the peninsula and is excessively arid throughout its extent." (Nelson, 1921, p. 71.) He designated several subdivisions in the Vizcaíño Desert, and discussed briefly the vegetative cover of several parts of the desert.

Shreve (1951, 1964) chose to include the Vizcaíño Desert merely as a subdivision of his "Vizcaíño Region" and devoted a few paragraphs to the distinctive vegetation of the Vizcaíño Plain, which is practically the same as the area Nelson called the Vizcaíño Desert, and which concerns us in this report. Shreve was a careful observer and an astute student of plant geography. During his field trips into the peninsula of Baja California, he tabulated and analyzed the floristic composition of the regions he recognized, and published lists of the plants he considered significant in delimiting phytogeographic areas. He wrote (1951, p. 110), "The dominant plant of the Vizcaíño Plain is *Yucca valida*, which forms from 60 to 80 percent of the number of large perennials throughout the northern part of the plain." On a following page he listed the principal perennials, indicating their relative abundance by asterisks, three such marks indicating the most abundant:

"The following are the principal perennials of the Vizcaíño Plain:

****Yucca valida*
****Franseria magdalenae*
****Lycium californicum*
****Encelia frutescens*
***Opuntia calmalliana*
***Foquieria peninsularis* [*F. diguetii*]
***Viguiera deltoides*
***Jatropha cinerea*
***Machaerocereus gummosus*
**Atriplex* species [*A. canescens*]
**Pedilanthus macrocarpus*
**Viguiera purisimae*
**Euphorbia misera*
**Opuntia ciribe*
**Prosopis juliflora* var. *Torreyana*
Larrea tridentata
Viscainoa geniculata
Lophocereus Schottii
Lycium Fremontii
Bursera Hindsiana
Lippia fastigiata
Pachycereus Pringlei
Triteleiopsis Palmeri
Solanum Hindsianum."

On 25 March 1961, four of us, Benjamin H. Banta, Alan E. Leviton, Allyn G. Smith, and I, left the San Francisco Bay area with the purpose of exploring as much of the Vizcaíño Desert as could be reached in the limited time at our disposal. We hoped to traverse many of the roads and passable tracks that cross parts of the desert. We had use of an International Harvester Travelall, owned by the Belvedere Scientific Fund, and financial support for the expenses of the trip generously furnished by the same fund through the kind interest and support of Mr. K. K. Bechtel. We here express our appreciation to Mr. Bechtel for his help on this, and other field trips, in Baja California made under his sponsorship.

TABLE 1. *Minimum night temperatures in the Vizcaíno Desert between 30 March and 8 April 1961.* (Thermometer 4 feet above surface of ground.)

Date	*Location of camp and weather notes*	*Min. temp. during previous night*
31 March	On desert 5 km. E. of Guerrero Negro. (Brisk breeze, overcast sky.)	6° C.
1 April	48 km. SE. of Guerrero Negro. (Brisk wind during night, full moon.)	8° C.
2 April	6 km. N. of Rancho Los Angeles. (Overcast between midnight and 2 A.M.; 24° C. at 8:30 A.M., 2 April.)	9° C.
3 April	15 km. N. of San Ignacio. (Little wind, temperature mild during day and evening.)	11° C.
4 April	2 km. E. of Rancho San Ángel. (Hot and dusty during middle of day; haze in afternoon. Temperature 16° C. at 8:20 P.M., 3 April, 12° C. by 6:30 A.M., 4 April.)	8° C.
5 April	Near beach 10 km. NE. of Punta Abreojos. (Heavy overcast and dew during night of 4th, light breeze.)	13° C.
6 April	5 km. SW. of Rancho San Ángel. (High overcast by midafternoon of 5th. Heavy dew during night.)	11° C.
7 April	3 km. N. of Rancho El Provenir. (Clear sky during night until 4 A.M. of 7th, then broken high overcast until 9 A.M.)	9° C.
8 April	38 km. N. of El Arco. (Chilly wind from NW. during night of 7th. Sky clear.)	6° C.

The aspect of the vegetation in the Vizcaíno Desert and the amount of activity among the animals that dwell there, vary from season to season and from year to year. This variation is inherent in the responses of organisms to the fluctuations in weather normal to any desert area, but is particularly apparent in the Vizcaíno Desert owing to the extremes in annual rainfall that may occur from one year to another. Such variations are less pronounced when one looks chiefly, or exclusively, at perennial plants, than when the total biota is under scrutiny. During a winter and spring of heavy—or exceedingly light—rainfall the response of the annual plants and of the invertebrates that live in, on, and around them is strikingly obvious. If the season is one of normal or more than normal rainfall, the desert blooms in an astonishing manner. (Such a winter and spring occurred a year after our visit, and at that time thousands of acres were bedecked with a veritable flower garden consisting of species of *Oenothera*, *Abronia*, *Nama*, *Orthocarpus*, *Layia*, and other conspicuous annuals. The contrast between the displays during the successive years was amazing, and is a part of the total seasonal and annual cycles in the Vizcaíno Desert, but such comparisons are beyond the scope of this paper.) If rainfall drops below the

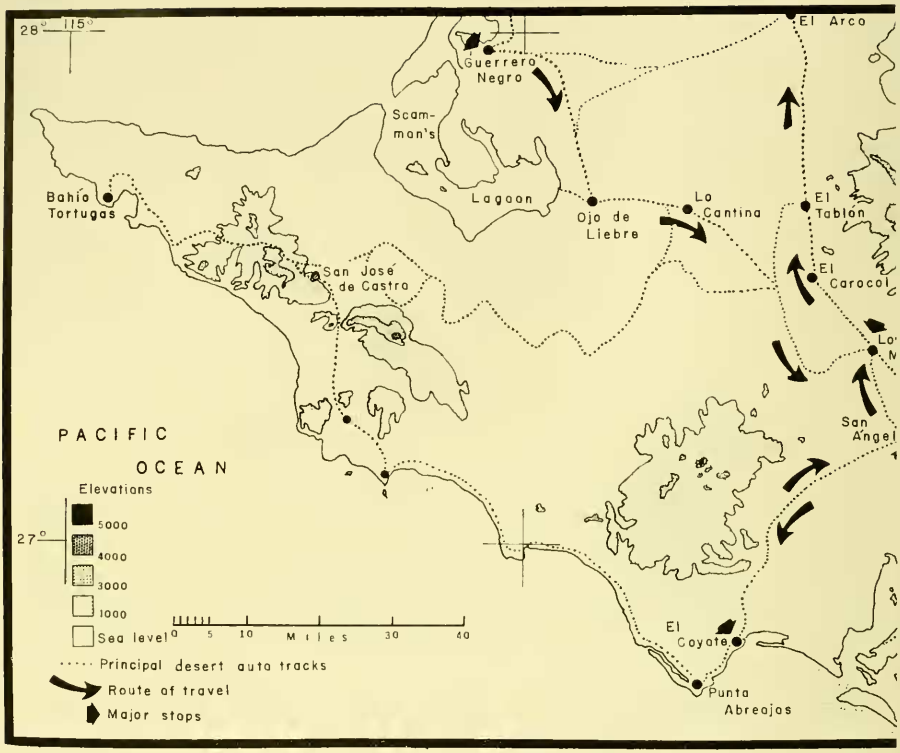
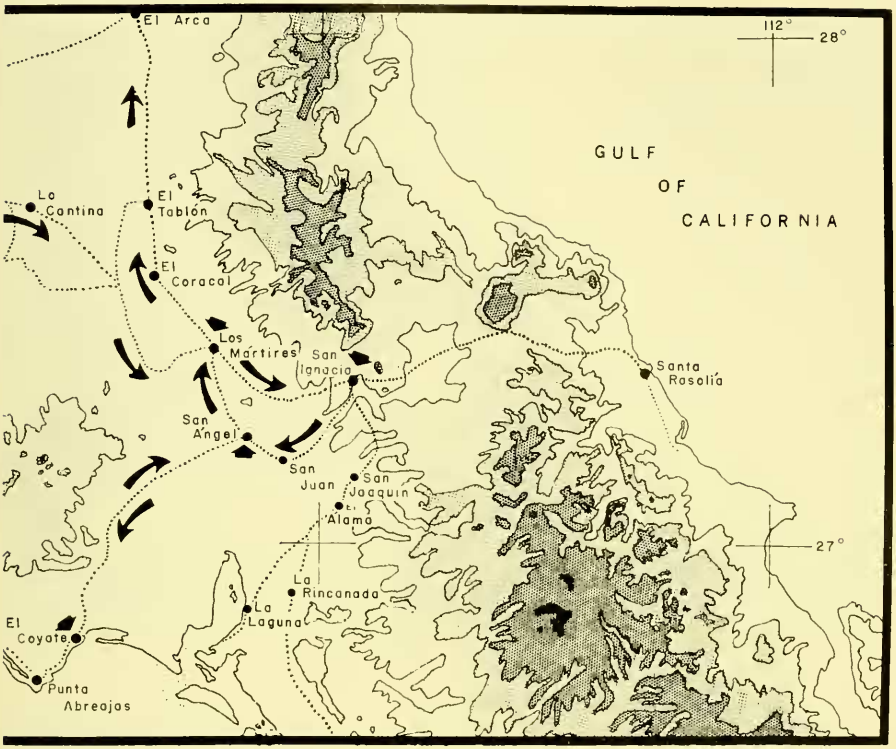


FIGURE 1. Map of Vizcaíño Desert and adjacent mountainous areas from Pacific Ocean to the Gulf of California, in Baja California, Mexico, showing itinerary of California Academy of Sciences 1961 Expedition to the Vizcaíño Desert. Many unmapped tracks of vehicles criss-cross the desert areas as a result of geological reconnaissance work carried out

annual average to an appreciable degree, or fails entirely, the annual plants and associated populations of insects may be almost totally absent.

The spring of 1961 was one during which the rainfall, although somewhat below average, was enough to bring about germination of many seeds of annual plants. But temperatures also were below the long-term average, so the growth of seedlings was exceedingly slow and they remained dwarfed, with few flowers present during our expedition. The low temperatures affected the fauna too, especially the reptiles, which were scarce almost everywhere. Cold biting winds blew nearly every day, and although no freezing temperatures occurred during our stay, the nights were chilly and the wind often made camping uncomfortable. The minimum temperatures recorded by a maximum-minimum thermometer placed in a shrub or tree near our camp each night are shown in table 1.

The effects of the nightly overcast and the heavy dew often are underesti-



under the auspices of the Mexican government. Most of them should be avoided owing to deep sand and jagged rocks. (Map adapted from aeronautical charts and drawn by Alan E. Leviton. It is divided into two parts with overlap as shown and printed on opposite pages.)

mated. Both nights when we camped near Rancho San Ángel, there was a pronounced overcast before dusk, and by 9 or 10 P.M. dew had accumulated on vegetation, our gear, and any object that cooled rapidly after sunset. By morning the drip from many shrubs was sufficient to make a moist circle in the sand, and this dampness often extended downward 4 or 5 mm. Some of the taller, leafless or nearly leafless, erectly branching shrubs showed less general drip, but the condensing moisture ran down the stems and branches into the sand where a damp ring 5 to 8 centimeters in diameter was apparent in the soil immediately around their bases. The soil in such rings was sufficiently moist for the particles to adhere well and to stain ones fingers with a muddy smear. The influence of the fog rolling inland stimulates the growth of lichens and its effects on these plants have been reported by several authors (Nelson, 1921, pp. 100, 135), (Shreve, 1951, p. 118). In parts of the Vizcaíno Desert, lichens are so abundant

that they constitute a menace to the health of many shrubs, while other lichens closely cover pebbles, cobblestone-sized rocks, and huge boulders. *Tillandsia recurvata* also depends mainly on fog and dew for moisture and forms conspicuous irregular balls of growth that resemble old bird nests. Such growths are obvious over many square miles.

We entered the Vizcaíno Desert at Miller's Landing, which is about at the point indicated by Nelson as its northernmost limit. From that point we followed the "main road" shown in Gerhard and Gulick's map number 8 southeastward toward Rancho Mesquital. Ten kilometers northwest of Rancho Mesquital (on 30 March), we examined a wash and adjacent foothills where huge granitic boulders are prominent topographic features and the following plants are the main constituents of the vegetative cover: *Yucca valida, Fouqieria diguetii, Opuntia calmalliana, Frankenia palmeri, Lycium californicum, Machaerocereus gummosus, Opuntia cholla, Euphorbia misera, Agave vizcainoensis* and *Jatropha cinerea.* A delicate grass, *Muhlenbergia porteri,* occurs commonly among the shrubs and under overhanging boulders, and *Cheilanthes peninsularis* grows in crevices among the rocks. Numerous dead whitened shells of two species of the snail genus *Micrarionta* were on the ground and among piles of debris left after winter rains. Living snails were present in small numbers, usually deep in crevices among the granitic boulders. Most of the boulders had undergone considerable exfoliation, and slabs, some a meter square or larger, could be pried from the more solid rock beneath. Under some of these slabs were occasional individuals of *Phyllodactylus xanti nocticolus.* A series of eight specimens of this small night-active lizard were collected. To our surprise, no additional specimens of this species were found elsewhere within the Vizcaíno Desert. Several grasshoppers were caught for Dr. Hubbell of the University of Michigan, but this insect was relatively scarce in the spring of 1961.

After entering the Vizcaíno Desert proper near this station, a search was made at 27 localities before we left the area again on the route north. Land snails were collected at only five of these stations. Three species of the larger forms were taken; there was a complete lack of minute species that occur elsewhere in Baja California, or at least we found none.

The most prevalent land snail collected was *Micrarionta levis,* a whitish

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Plate 1

Upper figure. Open stands of vegetation in northeastern part of Vizcaíno Desert. (Photograph by Allyn G. Smith.)

Lower figure. Clumps of *Frankenia palmeri* near Guerrero Negro. (Photograph by Ira L. Wiggins.)

species with a globose body whorl that is speckled with darker marking. These were taken at the following stations:

Station	Locality	Remarks
S-10	10 km. NW. of Rancho Mesquital	Dead shells only.
S-11	6.3 km. NW. of Rancho Mesquital	Few dead shells, 2-3 living.
S-12	5 km. NE. of La Espina (on a flat)	Common, all dead.
S-13	5 km. E. of Guerrero Negro	Common, all dead.

About 1.6 kilometers north of the buildings of Rancho Mesquital, we departed from the main road on a sandy track leading westerly to El Junco, Jesus Maria, and a secondary road that runs from Miller's Landing to Laguna Manuela. The sand was deep and soft west of the main road and four-wheel drive was used almost constantly for 4 or 5 kilometers. But in spite of the sand we made better time than we had for several days owing to the absence of sharp rocks and bad chuck holes in the two tracks that constituted the road. At a brief stop to look for snails and lizards 38 kilometers west of Rancho Mesquital, the desert supported a nearly pure stand of *Frankenia palmeri*, with a minor sprinkling of *Mesembryanthemum nodiflorum* and the dead remnants of *Plantago insularis*. The subshrubby plants of *Frankenia* were unusually dry, and showed no signs of swelling buds or recent growth at the tips of the branches. The complete aridity at this point illustrated the local nature of many of the rain squalls that sweep across the desert regions of Baja California. Often a strip a kilometer wide may receive a generous soaking, while the land on both sides of the path of the rain will remain totally dry. To our disappointment, this stop yielded no specimens of either snails or lizards.

A little over a kilometer before we reached El Junco, a track led southwesterly and appeared to be less sandy than the one curving northwest toward Jesus Maria. We took the left-hand fork and it joined the road running past Laguna Manuela about 2 kilometers east of the Laguna. We drove south several kilometers toward La Espina through desert very similar to that traversed between Rancho Mesquital and Laguna Manuela, thence westerly toward the salt harvesting establishment at Guerrero Negro.

The dominant plant on the flats in the vicinity of La Espina and Guerrero Negro is *Frankenia palmeri*. It rarely attains a height of more than 3 or 4 decimeters, and often is the only perennial seen over hundreds of acres on these saline flats. It tolerates a high concentration of salts in the soil, and except immediately after a drenching rain, the plants are covered with crystals of salt. These crystals are most abundant along the margins and under surfaces of the small lanceolate to elliptic leaves, but occur also on the stems, petioles, and sepals of the inconspicuous white or pinkish flowers. *Mesembryanthemum nodiflorum* and *M. crystallinum* are common in the area, but the two members of this

genus usually occupy the sandy ridges, dunes, and upper beaches, whereas *Frankenia* plants find the flat, caked, often very hard soil, where water stands after a rain or flooding by high tides, to their liking and rarely push upward on the sandy areas.

Near our camp of 30–31 March in this area, 5 kilometers east of Guerrero Negro, a single horned lizard, *Phrynosoma coronatum*, and two specimens of *Uta stansburiana*, were found in burrows, relatively inactive. A few small utas were observed scurrying about late in the afternoon, but the day was too cool and windy for most reptiles to be out.

In this same region, dead bleached shells of the land snail *Micrarionta levis* were numerous, but although we searched diligently among the *Frankenia* shrubs, we found no living specimens.

Along the immediate coast of Laguna Manuela and Laguna Guerrero Negro, the flats are subject to frequent overflow at high tide, and here the plant cover is largely *Salicornia pacifica*, with a small number of scattered plants of *Batis maritima*, *Limonium californicum*, and the parasitic *Cuscuta salina* which infests the *Salicornia* plants over wide areas.

The night of 30 March was windy, with a heavy overcast that lowered to ground level before the next morning, and the temperature dropped to 6° C. between darkness and dawn. We sought the scant shelter afforded by a shallow borrow pit where gravel had been hauled away to construct roadways for the salt trucks. Even in the depression the wind was sharp and, of course, dew soaked everything.

In the forenoon of 31 March, during a conversation with the Captain of the Port, an Englishman named Tillet, we learned that during the winter a gray whale and her young calf had wandered up the narrow arm of the estuary near the north end of Laguna Guerrero Negro and spent several days in the immediate vicinity of the salt-loading dock. Both whales seemed to welcome the presence of the ships and men and were surprisingly tame. One afternoon, after the mother and calf had been in the estuary for about two weeks, a group of eight killer whales swam in from the sea, attacked the pair, and quickly killed the calf. The cow put up a determined fight but was hopelessly outnumbered and died after a battle that lasted nearly two hours. Captain Tillet said that the gray whale had lost several hundred pounds of blubber and flesh under the onslaught of the killers. After killing their victims the killer whales left, without eating any of the carcasses save the flesh torn from the bodies of the living animals.

Captain Tillet mentioned also that a drop in the wind occurred a few days before our arrival, with an accompanying rise of 5° F. in the temperature of the water in Laguna Guerrero Negro. When the water warmed up, the gray whales in the main lagoon immediately left the area. According to him a light shower

had fallen during the night of 29 March which made the sandy roads easier to travel. The whole winter, he said, had been miserably cold and unusually windy.

Gasoline and other supplies are sometimes available at the salt works, at other times not to be had at any price. This is often true in a "company town" such as that at Guerrero Negro, for if visitors deplete the reserves on which local inhabitants depend, the latter may face serious losses through inability to meet the demands of machines and men engaged in operating the establishment. Owing to the fact that our group needed only about 80 liters of gasoline, was representing the California Academy of Sciences, and one of us had made contacts with the Superintendent on a previous trip, we obtained the precious fuel. He cautioned us that the situation at Bahía Tortuga is even less certain than at Guerrero Negro. Fishermen at the Bahía rarely have an excess of gasoline and recently had adamantly refused to sell any to motorists from the United States who arrived at the coastal village with nearly empty tanks. They were forced to wait more than two weeks until a fishing vessel with fresh supplies put into port, and then had to pay premium prices for enough gasoline to take them to San Ignacio, the nearest source of supply!

We learned, too, that the road between Ojo de Liebre and San Jose de Castro (see Gerhard and Gulick, map no. 9) is very sandy and hazardous for cars not specially equipped with oversize tires and extra low gears. The worst spots become completely impassable a few days after drying winds suck the moisture from the sandy wastes.

On 31 March we drove easterly from Guerrero Negro almost to Las Bombas, thence southeasterly toward Ojo de Liebre (Rabbit Spring) through partially stabilized dunes on which were stunted trees of *Prosopis juliflora* var. *torreyana*, a few scattered plants of *Yucca valida*, *Atriplex canescens*, *Atamisquea emarginata*, and a great many skeletons of *Mesembryanthemum nodiflorum*. In this area about 80 percent of the land surface is devoid of plant growth during a dry year, and dead shrubs that had succumbed to drought were numerous. Bell's sparrows were seen in considerable numbers working around the low shrubs and in the scanty litter beneath them.

Between Las Bombas and Ojo de Liebre there is no true "road" but a confusing maze of tracks that crisscross a strip that is often a kilometer wide. Consequently we missed Ojo de Liebre entirely, but reached a fork southeast of Huizache where a crude sign pointing southeast read "A la Cantina" and another pointing southwest read "San José." We chose the latter, hoping to reach Bahía Tortuga, then follow the coastal road to Punta Abreojos and inland to San Ignacio. But within a couple of kilometers we encountered saline flats that supported only a few scattered plants on sandy mounds, and the proportion of sand to firmer ground increased rapidly. This general area in the Vizcaíno

Desert is known locally as "Llano del Berrendo" (Antelope Plain) and we saw part of a bleached skull of one of these animals but saw no sign of a living pronghorn. In 1905, Goldman had searched for antelope near the southern end of the Sierra Santa Clara without success and obtained only one small deer during several days of hunting (Nelson, 1921).

With each successive kilometer traversed toward San José de Castro, the ground became more sandy and the vegetation less abundant. Reptiles were either absent or inactive owing to the relatively low temperatures, so we decided to forego the trip to Bahía Tortuga, fearing that our supply of gasoline would be exhausted before we could follow that route and reach San Ignacio. We turned back toward the forks and La Cantina.

During this entire day we collected only three reptiles, two specimens of *Uta* and a single one of *Callisaurus*. All three were taken among small sand dunes about 7 kilometers southeast of Guerrero Negro. Almost no intact snail shells and only a few fragments were found. There was no evidence of recently alive snails in that area.

We pitched camp 5 kilometers northwest of La Cantina on a flat where *Atriplex canescens* formed a meager windbreak, and the main plant cover was *Frankenia palmeri*. After we had eaten our evening meal, we placed some leftover food a few feet from our vehicle at the margin of a *Frankenia* thicket. Within five minutes one of the graceful little desert foxes approached the food silently as a shadow, picked up a portion, and trotted away into the concealing shrubbery. In about two minutes she reappeared, paid no attention to the beam of a flashlight, and departed with a second morsel. This time she left the area in a direction different from the one taken the first trip. We watched her reappear at intervals for nearly half an hour, during which she cleaned up every crumb of food, inspected us intently for a few seconds each trip, then melted into the low gray bushes. She obviously was nursing kits, and was unafraid of us, but distrusted us as far as revealing the direction in which her den was located.

The next morning (1 April) we witnessed a loggerhead shrike attack a horned lark in full flight, drive it into a bush of *Lycium californicum*, and quickly kill it. The shrike impaled the body of the smaller bird on a spine of the *Lycium* bush and began to peck at its head. Within five minutes the skull of the horned lark had been pierced and all save a few shreds of brain tissue removed. The rest of the lark's body was left hanging from the spines of the *Lycium* bush, with only a few feathers rumpled (Wiggins, 1962).

On 1 April we continued to Rancho La Cantina and found the vegetation very sparse and other collecting little better. However, during the previous year there had been a local shower of considerable intensity, and it had stimulated growth of some annuals to a remarkable degree. For a distance of about 5 kilometers there were dead stalks of *Sphaeralcea coulteri* fully two and one-half

meters tall! Normally this plant is less than one-third that high. On sandy hummocks in the same area were occasional thickets of *Lycium californicum* and scattered shrubs of *Atriplex canescens* and *Atamisquea emarginata*. Two kilometers farther on there was no evidence of any increase in rainfall and vegetation—or its dead remains—was as depauperate as that over most of the Vizcaíno Desert in 1961.

After we left the flat plain in the vicinity of Guerrero Negro, we collected no more specimens of *Micrarionta levis* snails until we were well out of the Vizcaíno Desert near Rosarito on our return trip. At station S-13 (= VE-13) 5 kilometers east of Guerrero Negro, many of the snails had been killed and eaten, probably by rodents, which had bitten the tops out of the shells of any live snails they had found.

A second type of land snail we found in the Vizcaíno Desert was *Micrarionta peninsularis*, a rather flat-coiled, fawn-colored species with an encircling dark brown band on the body whorl. This snail belongs to a different subgenus than that in which *M. levis* is placed. It was collected at several stations north of the Vizcaíno Desert, but after the La Espina-Guerrero Negro station we did not find it again until we were about out of the desert near Rancho Mesquital. There we found a considerable number of shells, all dead, among red lava rocks on a sidehill with an eastern exposure (station VE-59, S-36).

By mid-afternoon on 1 April, the wind died to a gentle breeze and the temperature rose quickly to a level that made coats unnecessary. Immediately we began so see an occasional lizard. While Banta and Leviton hunted for them, digging into sandy mounds that had been riddled by the burrows of small rodents, Allyn Smith sought snails and found a few bleached shells.

This day brought more success to the herpetologists than they had experienced earlier on the trip, for they collected 22 reptiles at five localities only a few kilometers apart, most of the specimens being taken right after the temperature rose. The reptilian specimens taken included five genera, with specimens of *Callisaurus, Cnemodophorus, Crotophytus, Sceloperous*, and *Uta* represented, with *Uta* most numerous (11 specimens) and *Callisaurus* a close second with nine individuals obtained. All were taken on the sunny sides of sandy ridges and dunes, often at or near the mouths of burrows.

As we continued toward the east, the character of the soil and of the vegetation began to change. There were more pebbles and cobblestone-sized chunks, fewer "alkali" flats, and a considerable enrichment in the flora. Ten kilometers east of Rancho la Cantina, the bushes of *Atriplex canescens* still were present but no longer made up the bulk of the shrubby vegetation. Intermingled with the bushes were two herbaceous species of *Atriplex, A. barclayana* and *A. julacea*, living plants of *Mesembryanthemum nodiflolium*, a few plants of *Ditaxis* and *Stillingia*, and the dried remains of an herbaceous composite that was unidentifiable.

Along some of the water courses were stunted shrubs of *Prosopis juliflora* var. *torreyana*. *Lophocereus schottii* grew on some of the sandy mounds, and the burs of the Desert Sandbur, *Cenchrus palmeri*, were so numerous in places that they covered 50 to 90 percent of the surface. Plants of *Franseria magdalenae* were present but uncommon, and always in the lea of sand dunes. Cottontail rabbits were fairly common, and we jumped several of them while we searched among the thickets. Sickle-billed thrashers were seen from time to time and horned larks were numerous.

At Wilson's Ranch a field crop was being cultivated and a dozen or more caracaras were following closely behind the tractor. They seemed to be finding good foraging among the insects, mice, and probably lizards being brought to the surface. They "leap frogged" one another as they followed the cultivator, hopped to one side when the tractor turned at the ends of the rows, then repeated their antics back to the opposite side of the field. These part predator, part scavenger birds indulged in what looked like "play" as they worked back and forth across the field, chasing each other, engaging in mock battles, and performing agile patterns of movement both afoot on the ground and in the air a few feet above the soil.

"Wilson's Ranch" is officially named Rancho Santa Margarita, but most of the local people call it by the name of the American who was chiefly instrumental in developing it in partnership with Mexican citizens. The presence of this thriving ranch shows how fruitful the land can be if water is available. Water for irrigation is pumped from wells, described as "deep" without definition of that term. The water is piped to the fields and applied from overhead sprinklers. Excellent crops of grain, beans, cotton, and other small crops are grown, and some trees have been planted. One wonders if sugar beets might do well in some of the more saline soils a bit farther west if water were available in that region also.

As an indication of how rapildy the temperatures on the Vizcaíño Desert can—and do—change during a 24-hour period, we were comfortable in shirt-sleeves at noon on 1 April. There was almost no breeze. But after making camp at 5 P.M., we found jackets essential for comfort and by 7:15 P.M. the temperature inside the car, totally protected from the wind that had reached a velocity of

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Plate 2

Upper figure. *Pachycormus discolor* [Elephant Tree] heavily draped with lichen, *Ramalina reticalata*. (Photograph by Allyn G. Smith.)

Lower figure. *Lophocereus shottii* and *Yucca valida* on sand dunes 15 kilometers southeast of Guerrero Negro. (Photograph by Allyn G. Smith.)

8 to 10 kilometers per hour, was 19° C. During the ensuing night the thermometer reading dropped to 9° C., and then rose to 24° C. by 8:30 A.M. on 2 April.

Greater variety among the plant species is the rule along the eastern margin of the Vizcaíno Desert, where it gives way to the foothills and plateau area, than on the central and western flats. The ranker growth and larger numbers of perennials in this foothill area probably are owing to a number of factors, but a higher rainfall, a less saline soil, a greater diversity of habitats, and the presence of water at or near the surface along outwash bajadas and in arroyos combine to make the ecological situations more favorable for a greater number of plants than is presented on the flats. At our camp on the evening of 1 April, 15 species were common or abundant. All save two of them were shrubs or trees. They were: *Yucca valida*, *Lycium californicum*, *L. berlandieri*, *Larrea tridentata*, *Encelia farinosa*, *Opuntia cholla*, *O. calmalliana*, *Lophocereus schottii*, *Machaerocereus gummosus*, *Atriplex barclayana*, *A. canescens*, *Viguiera deltoides*, *Eriogonum scalare*, *Euphorbia xantii*, *Stillingia linearifolia*, and *Pachycereus pringlei*. The last named cactus often gives a distinctive appearance to the landscape, even when it is scantily represented in the total population. Its massive, nearly erect arms tower above all other plants of this area and easily dominate the skyline. Between Rancho Los Angeles and Rancho El Provenir, there are stretches where the vegetation is composed almost exclusively of *Pachycereus pringlei*, *Larrea tridentata*, *Yucca valida*, *Lophocereus schottii*, *Machaerocereus gummosus*, and a few scattered shrubs of *Encelia farinosa*. (For the location of these ranches, see Gerhard and Gulick's map no. 10.)

Near Rancho El Provenir, we encountered a truck driver whose vehicle blocked the road. His engine had died and his battery was too low to restart it. Since his truck had no bumper, we could not push it with the Travelall, nor could we get around him and tow the truck, so the four of us pushed his truck, by man-power alone, and got it started! With a smiling "Muchas gracias!" and a flip of his hand, he drove away toward San Ignacio. Presumably he had no further trouble for we did not overtake him.

Herpetological collecting was far better than we had enjoyed on any previous day, from the standpoint of variety, for on 2 April two rattlesnakes were captured, one from beneath a dead, termite-riddled *Yucca valida* trunk lying on the ground, the other out on the surface late in the afternoon. Other genera obtained included the following, with the number taken included in parentheses: *Callisaurus* (4), *Cnemodophorus* (3), *Sceloporus* (2), *Uta* (4) and *Xantusia* (7). Both specimens of *Crotalus* were beautiful snakes, with skins in excellent condition.

Our camp on 2 April was about 15 kilometers north of San Ignacio, in an area of rolling hills, moderate-sized outwash slopes, rounded ridges, and small

arroyos. The soil was reddish or gray, depending on the character of the parent materials, which vary considerably in a short distance. The surface is covered with volcanic erratics that vary in size from pea-gravel to boulders as much as a meter in diameter. Caliche is well developed in the area and is widespread if not uniformly present. All cuts and washes show layers of it, and in many places the caliche was 3 to 4 decimeters in thickness. This calcareous stone is burned in small kilns fired with mesquite and tesota (Olneya, or Ironwood) to furnish lime for masonry around the ranches, in San Ignacio, and we were told, as far away as Santa Rosalia (Gerhard and Gulick, map no. 11). The lime appears to be of good quality.

The most important land-snail find in the Vizcaíno Desert was the discovery of an apparently large colony of *Bulimulus lamellifer* at this camp. This is a whitish or buff-colored snail, elongate in outline, with a peculiar lamellar extension of the columella inside the aperture. Many dead shells of this species occurred in an area strewn with lava boulders along an arroyo that trends north-south. The snails were found from 1 to 4 decimeters below the surface in partially consolidated piles of rock and also in a nearby caliche rockslide under the overhang of an arroyo bank shaded by a heavy growth of mesquite, cardon, and several other shrubby plants. The locality is in a dry hot area. After considerable "mining" into the rocks, we were able to collect only a couple of living immature snails. Apparently we missed the main concentration of the living representatives of the colony, if, in fact, it still existed. A number of other species of the genus occur farther south, especially in the Cape Region. Our collection 15 kilometers north of San Ignacio provided an exact collecting locality for this species which was discovered by W. M. Gabb many years ago, but he did not indicate the exact locality at the time.

Several species of plants not seen out on the Vizcaíno Desert proper were present in the near vicinity of this campsite. *Cercidium microphyllum*, *Olneya tesota*, *Haematoxylon brasilleto*, and *Lysiloma candida* grew along the arroyo among the volcanic rocks, on the ridge a few meters higher were fine plants of *Bursera microphylla*, *B. hindsiana*, *Fouquieria diguetii*, and *Jatropha cinerea*. The last species is very abundant from this general area south to the Cape Region, and sporadically present at various localities considerably farther north, but not out on the drier parts of the Vizcaíno Desert.

Over a period of a decade or more, the presence of small black or green beetles inside the flowers of *Opuntia invicta* and in those of *Echinocerus engelmannii*, had attracted my attention. These beetles are present soon after the flower opens, and continue to be present until the tips of the petals wither, deliquesce, and stick together so tightly that they effectively imprison at least a part of the insects. Sometimes the green beetles predominate, sometimes the

black, and sometimes both kinds are present in a particular flower in approximately equal numbers. Judging from the part of the flower to which they seem to converge, they probably feed on the nectar that occupies the bottom of the floral cup. Some are usually among the anthers at the tips of the stamens also, so it seems likely that they eat some of the pollen. There were numerous plants of *Opuntia invicta* near our camp of the night of 2 April, so about 20 flowers that were open and a similar number of closed ones were examined for the presence of the beetles. Flowers that had opened on the morning of 3 April were inhabited by either the small black beetles that were about 2 or 3 mm. long, or by the iridescent green ones about one-half again as large as the black species. Not a single flower was found that was free of beetles, and the number present in a flower varied from 3 or 4 to as many as 15 or 20. One flower on a plant separated from the other plants by a distance of about 80 meters was swarming with over 40 beetles among its stamens and around the nectar-bearing ring at the base of the cup. All these beetles were active, and the stamens were moving actively also, since they are sensitive to mechanical stimulation and tend to bend inward toward the styles when touched near their bases. This inward curving of stimulated stamens may be an effective adaptation for insuring pollination even when larger insects that flit from flower to flower are absent.

The closed flowers also, without exception, contained several beetles. In contrast to the very lively behavior of the insects in the newly opened flowers, the beetles entrapped in the closed blossoms moved sluggishly or were quite torpid. A few of the latter would move a leg or two, others crawled slowly when prodded, but still others either were dead or "anaesthetized." They appeared to have become drugged by the nectar, or pollen, after they had dwelt in the flower a few hours. All of them were generously dusted with the golden pollen from the numerous anthers. Seventeen of the small black beetles were collected from one flower.

Insects of various kinds were far more numerous at this camp than they had been at any previous stop on the trip. They flocked to the gasoline lantern in large numbers and at least 200 individuals were captured when they lit upon the white sheet hung between shrubs.

Another valuable find in the vicinity of this camp was a beautiful specimen of a small burrowing snake that seems to "swim" into and through soft sand. This representative of the genus *Sonora* was obtained by Dr. Leviton deep in the blow-sand that had accumulated around the base of a shrub.

About 8 kilometers northwest of San Ignacio we saw the first reasonably large colony of *Lysiloma candida*. It is a graceful tree, with sharply ascending main branches and pendent dark gray-green leaves near the tips of the smaller twigs. The bark is milky white, smooth, and reminds one of the birch trees in

the northeastern United States. It is used extensively in tanning hides to produce a fine quality of leather. With the *Lysiloma* trees occurred a few venerable mesquite trees and a number of those of *Olneya tesota*.

A second valuable collection was made on 3 April, a series of specimens of *Hyla* caught along the stream that flows past the village of San Ignacio. These little frogs are elusively active when startled, so it is not easy to capture many of them in a restricted area during the daylight hours. At no other locality in the Vizcaíño Desert did we find enough water sufficiently fresh to support a population of this frog. (A few mature specimens and a number of tadpoles were collected near Mision Calamajué on our trip back toward the United States, but these were well outside the limits of the Vizcaíño Desert.)

Fresh-water snails of the widespread left-handed genus *Physa* were found at two places in the Vizcaíño Desert. It was collected first in the flowing stream at San Ignacio, along with a couple of specimens of ram's-horn snails of the genus *Planorbella*, and again 30 kilometers north-northeast of Punta Abreojos in a small spring pool at the foot of a steep grade used by trucks bringing "langosta" out for shipment to the mainland of Mexico. This spring is an important source of drinking water in the area and is used regularly by fishermen and truckers.

After a brief stop in San Ignacio to fill our tanks with gasoline and to purchase a few supplies, including several cans of mangos that were delicious, we located the road to San Sabás, San Juan, and San Ángel (Gerhard and Gulick, map no. 10), with the intention of driving to Punta Abreojos and possibly to San Hipólito and Bahía Tortugas (Gerhard and Gulick, map no. 9). Our route was roughly that taken by Goldman in 1905 to hunt antelope, when he found a waterhole in the Sierra Santa Clara not previously shown on any map. Comparison of the Nelson map of the area with that of Gerhard and Gulick raises some intriguing questions. Either the rancho named San Juan near San Ignacio has moved its headquarters since the time of Goldman and Nelson, or their map is inaccurate in that particular instance. They showed San Juan west and slightly north of San Ignacio, but at present it is definitely about 25 kilometers *southwest* of San Ignacio.

Our camp on the night of 3 April was only one kilometer east of San Ángel, for we believed the ranch to be occupied and we preferred to avoid protracted visiting that accompanies a stop at such a rancho. The Sierra Santa Clara was visible as a deep-blue featureless mass on the western horizon, with nothing, apparently, but flat saline playas and rolling shifting sand dunes between us and the distant range. During the evening and well after dark, we heard the cries of migrating shore birds overhead.

A reddish haze overlaid that part of the Vizcaíño Desert, caused, we thought, by fine dust suspended in the air. There had been a moderate to brisk breeze much of the day and at times clouds of dust were swept off the desert floor and

swirled into the sky. But dust in the air did not reduce the amount of dew, for by 8 P.M. our ponchos, ground cloths, and other gear dripped and the temperature was down to 16.5° C. A field note states that we felt "hot and dirty in the middle of the day, but decidedly cool by evening."

The whole day of 4 April was devoted to reaching the vicinity of Punta Abreojos. The road was sandy much of the way, there were several salt flats that could be treacherous after a rain, and miles of partially stabilized and actively shifting dunes alternated with one another. The west-bound traffic appeared to be keeping on one set of tracks and the vehicles going east used a different set 2 or 3 kilometers farther south. Our mileage for the day was poor. By the time we reached the beach about 10 kilometers southeast of Punta Abreojos, we had made an average of 3.2 miles per gallon of gasoline!

The Sierra Santa Clara was tantalizing. It was skirted around its southern end, for it is a rugged volcanic range, with huge blocks and flows of lava in which small terraces and pockets of soil occur. During a year of good rainfall it would be a botanist's dream, for there were dead reminders of *Eriogonum*, *Abronia*, *Oenothera*, *Sphaeralcea*, and several different grasses and many annual forbs too fragmentary at the time of our visit to be identified. *Bursera microphylla* grows there as a low, sprawling, gnarled tree no more than 3 or 4 meters tall. One patch of soil no larger than a moderate-sized city lot was closely covered with the dead stalks of *Eriogonum scalare* and an unknown species of *Boerhaavia*. Dead whisps of annuals caught in the crevices among the rope-like lava gave a hint, but only a hint, of the lush beauty that must cloak the area during a spring of high rainfall.

Diligent search near our lunch stop at the southern tip of the Sierra Santa Clara revealed a dishearteningly small number of reptiles, but whether this indicated a permanent low density in the region or was merely the result of the subnormal temperatures at that season was not apparent. Suffice it to report that during the whole day, although numerous stops and searches were made, the total take of lizards amounted to one specimen of *Sceloporus*, 13 of *Uta*, and four individuals of *Xantusia*, the latter found under the dead decaying stems of *Yucca valida* and of *Pachycereus pringlei*. Eight of the utas were taken on the rocks at the southern end of the Sierra Santa Clara, and were the only reptiles seen in that vicinity.

Cacti were represented in the area around the southern tip of the range by stunted plants of *Lophocereus schottii* of which some were in flower, an occasional plant of an unidentified *Cylindropuntia*, and a few scattered nubbins of a *Mammillaria*.

The road drops abruptly down a narrow gulch from the shoulder of the plateau to the foot of the mountain slope and thence across a nearly level stretch several kilometers wide to the beach. A short distance out on this level ground a

faint track swings northward, and less than 1 kilometer from the main road is a small spring, marked by a narrow strip of salt-tolerating grasses and a few stunted trees of mesquite and *Bursera*. This spring was one of the two localities at which we collected *Planorbella*, first taken in the stream at San Ignacio. The water is slightly brackish but is used regularly. This is not the spring found by Goldman, for his spring was considerably farther north and on the eastern flank of the range. Probably there are other seeps that might be developed, as this one has been, by judicious excavating around or above the point where water shows at the surface. The flora bordering the minute oasis was made up chiefly of salt-resisting plants such as *Frankenia palmeri*, *Distichlis spicata*, and *Mesembryanthemum nodiflorum*.

At the end of the day (4 April) we camped in a swale a few dozen meters from the beach, about 10 kilometers northeasterly from Punta Abreojos. Two small adobe-and-packing-case huts stood about half a kilometer from us. The next morning we learned that they were unoccupied, but had been used recently by lobster fishermen. Thousands of empty carapaces were strewn about and evidence of groupers having been caught in fair numbers was present also. Two mangy dogs were seen at a distance, but they were far too suspicious to permit close approach.

The only opportunity to collect marine shells was at this camp. Here we were able to make a small collection, limited by available time and the condition of the tide. We obtained a good series of chitons from the partially exposed rocks. The large colorful *Stenoplax magdalenensis* was common in the area. Often a single large rock harbored from five to ten of these chitons on its under side. Just back of the tide line was a low cliff formed by an ancient raised beach containing post-Pleistocene fossils, mostly large bivalves.

We were within sight of the lighthouse at Punta Abreojos, but a careful calculation of mileage achieved against gasoline consumed, and compared with the amount of fuel still in our tanks, showed the folly of continuing northwest toward an uncertain resupply! Reluctantly we reversed our course and headed back toward the main road north.

After climbing the steep pitch to the plateau on which the Sierra Santa Clara stands, and threading the rocky rough pass through the range's southern tip, we took the southerly of the two routes in order to avoid meeting a west-bound truck in the deep sand. About 17 kilometers inland we found a few plants and two individuals of *Uta*, the latter dug from burrows under a dry shrub. In general, the southern route had more vegetation along its course than we had found beside the northern track, so possibly the amount of condensation is higher even that short distance nearer the ocean. At various points along our eastward line of progress we saw the following: *Lophocereus schottii*, *Cercidium microphyllum*, *Atriplex canescens*, *Hyptis emoryi*, *Euphorbia magdalenae*, *Prosopis juliflora*

var. *torreyana*, *Olneya tesota*, *Opuntia ciribe*, *O. invicta*, and *Pachycereus pringlei*. We drove through one patch of Creosote Bush (*Larrea tridentata*) nearly one-half kilometer wide where this shrub covered about 20 percent of the ground. Sparser patches of the shrub were seen at intervals throughout the day. We crossed one salt flat about 3 kilometers long and varying from about 200 meters to a kilometer in width, that was covered with a layer of salt nearly a decimeter thick. The crystallization process had generated intense expansion pressures, so the surface was broken into polygons 2 to 5 meters across that had their margins curled upward 2 to 4 decimeters. The salt was glistening white, held none or little of the usual bitter taste associated with unrefined salt reclaimed from sea water, and appeared to be pure enough for domestic use. Not a spear of vegetation grew in the flat, although the usual sparse assemblage occurred on the sandy areas a few meters from the salt deposit.

We noted that along the route from Punta Abreojos to Rancho San Ángel the plants of *Fouquieria*, *Atriplex*, and *Jatropha* were confined to the rocky ridges, while *Larrea tridentata*, *Plantago insularis*, *Atriplex barclayana*, *A. julacea*, *Lycium brevipes* and *L. californicum* inhabited the flatter more-sandy areas.

No snails of consequence were collected this day, and the only lizards captured were 18 specimens of *Uta*.

We camped the night of 5 April along the southern margin of a vast expanse of dunes where the vegetation had not yet stabilized more than about one-fifth of the shifty sand. A saline pool a few meters long contained a brine shrimp but no algae that we could detect. Some kind of higher plant had grown in the pool, but at the time of our visit it was dead and unidentifiable. It looked like a species of *Ruppia* or *Najas*, but heavy encrustation of salt on the fragments made the plants too brittle to remove from the water intact.

Until midafternoon on 6 April was devoted to exploration of the sand dunes to a depth of nearly 5 kilometers. Lizards were present in fair numbers, the most we found at any one station during the entire trip. Dead snails were present under some of the shrubs and a few trees of *Prosopis*, *Cercidium*, *Bursera*, and *Olneya* still held old fruits.

An undetermined distance to the north of this area is a remarkable expanse of sand, seen from the air by me in 1959. On a flight from San Ignacio to Guerrero Negro in Mr. K. K. Bechtel's Lodestar, the plane was at an altitude of about 3400 meters. A slight haze partially blurred the Sierra Santa Clara. Below us there was a topographic feature totally unfamiliar to us. A large area of the Vizcaíno Desert looked as though giant windrows of sand had been formed, each one parallel to the adjacent ones, and stretching several kilometers with virtually no breaks in their longitudinal continuity. In 1961 the editors of *Life* issued the book, *The Desert*. On page 32 a marginal drawing depicts the surface

Figure 2. Transverse dunes in central Vizcaíño Desert south of Guerrero Negro, photographed from airplane at altitude of 3400 meters. (Photograph by Ira L. Wiggins, black and white negative made from Kodachrome transparency by Maurice Giles.)

structure seen from aloft in 1959. It is a series of "transverse dunes" which, according to *The Desert*, are ". . . the products of moderate, one-way winds . . . which move only light sand. Tumbling air eddies swirl heavier grains to the sides, which make ridges." (Leopold, p. 32, 1961). No record has been found of this type of dune in North American deserts. How we wished we had the time and specialized equipment to trek into the region and investigate those transverse dunes! Similar longitudinal dunes have been reported from Australia.*

Another check of our gasoline supply indicated that we had sufficient fuel to reach El Arco, so we took the road from Rancho San Angel direct to Rancho Los Mártires, a distance of 20 kilometers instead of the 75 kilometers required to travel by way of San Ignacio. The first 3 kilometers northward from Rancho San Ángel are through heavy soft sand. Four-wheel drive and compound low gear were required to grind through. After that short stretch the road was very rough, filled with rocks and boulders for an additional 6 kilometers, then

* See Marbutt, J. A., and M. E. Sullivan, "The formation of longitudinal dunes: evidence from the Simpson Desert." The Australian Geographer. Journal of the Geographical Society of New South Wales, vol. 10, no. 6, pp. 483–487, figs. 1–3 in text, pl. 1, September, 1968.

ran over firm silty sand that allowed a speed of 30 to 35 kilometers per hour. It is a road to be avoided by a stock car owing to the high centers and many sharp rocks, some of them hidden in clumps of grass or small shrubs. This road should be viewed with suspicion even in dry weather, for even with four-wheel drive and low speed gears, axles can be sheared under the strain of plowing through the sand. Local drivers rarely use the route except for a short period immediately following rains sufficient to pack the sand, but not heavy enough to greatly soften the firmer portion and cut it into deep muddy ruts.

The time spent in the sand dunes paid fine dividends in the number of reptiles collected. The day's accumulation of specimens for each genus represented were: *Callisaurus* (34), *Cnemidophorus* (4), *Crotophytus* (1), *Sceloporus* (1), and *Uta* (16). Some dead snails but no living ones were found.

Before leaving San Francisco we had been briefed by Dr. Edward S. Ross, Curator of the Academy's Department of Entomology, to be on the lookout for "web-spinners" (Embioptera), a group that is his specialty. Although we made a careful search in many localities throughout the Vizcaíno Desert and found embiid silk runways at several spots, our efforts met with nothing but failure until we reached the dune area near San Ángel. There our efforts finally were rewarded by the discovery of a single living specimen under a mass of dried cow dung in a swale among the dunes. We were able to get the little creature home alive, where Dr. Ross pronounced it to be an undescribed species. Our field notes indicate that we found embiid silk runways at the following locations, which are mentioned in order to provide information about other places where these insects might be collected subsequently:

Station	*Location*	*Remarks*
VE-24 (S-17)	1.6 km. S. of Rancho El Caracol.	A flat plain; sandy loam area in cardon and yucca deadfalls.
VE-32 (S-22)	6.6 km. NW. of Rancho San Juan (1 km. SE. of San Ángel).	Under dried cow dung.
VE-32 (S-24)	Same general area.	Many runways under and among cardon and yucca deadfalls and under dried cow dung.

We collected insects of many kinds as often as we could find them for the Academy's Department of Entomology. These included beetles, moths, butterflies, grasshoppers, and other forms, as well as scorpions and centipedes. At nearly all of our camp stops we spread a white sheet and collected everything that was attracted to the brilliant light of a gasoline lantern.

We camped on an almost level flat covered with a beautiful example of

desert pavement on the night of 6 April, about 3.5 kilometers north of Rancho El Provenir, and about 13 kilometers south of Rancho Los Angeles. Parenthetically, Rancho Los Angeles was occupied in 1961, but 30 years earlier when I drove through it on the way to the Cape Region, and again on the return trip, Rancho Los Angeles was marked only by the remnants of a brush shack and a few parts of a long-dismantled windmill. Professor James I. McMurphy and I had broken the main leaf in the front spring of our Model A Ford station wagon a few miles south of Rancho Los Angeles, so we cannibalized part of a rusty tire from a wagon wheel with which to truss up the broken spring. With that makeshift repair we drove clear to San Diego without further difficulty, save that of changing the position and rewiring the length of tire from time to time.

In the vicinity of our camp on the western foot of the hills leading up to the Sierra the vegetation was mainly *Yucca valida*, with *Opuntia cholla* second in abundance, and with the following in the order of relative abundance: *Pachycereus pringlei, Opuntia calmalliana, Fouquieria diguetii, Machaerocereus gummosus, Jatropha cinerea, Larrea tridentata, Cercidium microphyllum*, and *Lycium andersonii*.

The evening was clear as crystal, the stars brilliant and seemingly within reach of our finger tips, and the insect collecting was abominably poor! Almost no insects came to our light, and the lowering temperature drove us to the comfort of our sleeping bags before 9 P.M. The temperature was down to 15° C. before 8:15 that evening.

During the night it became still colder, down to 9° C., at about 4 A.M. Accompanying the drop in temperature was a heavy overcast, so the entire sky was dull a little after midnight until 9 A.M. the next morning.

At about 11:30 A.M. on 7 April, we reached a road leading westerly to "Meestair Weelson's Rancho," and marked by a sign that read: "Centro Ganadero Cuauhtemoc Camp Experimental No. 1" and in smaller letters, "Impulsora Agricola y Ganadero S. de R. L. con Cooperacion de la Comisión Nacional del Olivo." Most of our course during the day led through country that could be adapted to agriculture *if* reliable sources of water were available. Probably a few years of pumping will determine whether the wells drilled by Sr. Wilson will continue to produce or run dry. If underground sources are sufficient, many

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Plate 3

Upper figure. *Coleonyx variegatus* taken from decaying trunk of *Yucca valida* south of Rancho Mesquital. (Photograph by Ira L. Wiggins.)

Lower figure. *Opuntia invicta* flower, 5 kilometers south of Los Martires. (Photograph by Ira L. Wiggins.)

thousands of acres along the eastern edge of the Vizcaíno Desert may become highly productive fields and orchards. But an adequate supply of water and plentiful fertilizer are going to be prime requisites for such development.

The silty gray soil, with reddish lava blocks and pebbles strewn over the surface along the run-off channels, supports a fairly good cover of desert vegetation when there is rain in the winter months. In a year of good rainfall the sandy soil is carpeted with myriads of seedlings of *Oenothera*, *Plantago*, *Cryptantha*, *Cenchrus*, *Sphaeralcea*, *Malacothrix*, *Nama*, and a number of annual herbs. *Pedilanthus macrocarpus* is conspicuous in some areas. Other shrubby plants are generally those enumerated several times in the preceding pages. The endemic shrub *Viscainoa geniculata*, is often conspicuous along washes and bajadas.

Before the end of the day (7 April) we stopped in El Arco long enough to fill our tanks with gasoline, then proceeded a few kilometers to pitch another chilly, windy, dew-moistened camp. The night was cold, with a minimum temperature of 6° C.

During the day we made one good collection. Four specimens of *Coleonyx* were taken from under *Yucca valida* deadfalls, the first time this lizard had been seen on the trip. In addition we got 3 specimens of *Sceloporus*, a single one of *Uta*, and 6 of *Xantusia*, every one of them under dead trunks and branches of fallen yuccas.

Near our camp on 7 April, in addition to many species of plants seen along the road during the day, we found *Franseria dumosa*, a plant mainly growing farther north and penetrating the Vizcaíno Desert only a short distance.

On 8 April we got gasoline at Rosarito in the late afternoon and camped in the rolling hills among *Idria* trees a few kilometers north of the village. The site undoubtedly had been used only a short time before we got there, for we caught three fleas on the sheet stretched in front of the lantern. The temperature dropped to 5° C. during the night.

On 9 April we passed through Punta Prieta, and 40 kilometers north of that village we took the easterly fork of the road, leading to San Felipe (see Gerhard and Gulick, map no. 7). By that time we were still within the area Shreve called the "Vizcaíno Region" but outside the limits of the Vizcaíno Desert. Our route was past massive granitic hills, with an occasional volcanic cone or lava flow, down a sandy and rocky canyon to the barely distinguishable ruins of Misión de Calamajué, thence past more granitic hills, across innumerable washes to the volcanic hills between Bahía San Luis Gonzaga and San Felipe. These hills are often skirted, but sometimes the road climbs to the top of narrow sharp ridges over steep, tortuous, rocky stretches. It is an area that tests the skill of a driver to miss tire-damaging sharp rocks, yet keep clear of jutting boulders and overhanging embankments.

One notable collection of amphibians was made in the stream near Misión de Calamajué. Several mature specimens and a fair series of tadpoles of *Hyla* (the same as that taken at San Ignacio) were obtained here.

Some strenuous labor was involved in digging into the loose rocks of talus slopes a few hundred meters upstream from the *Hyla* locality in search of snails. A few specimens of *Micrarionta* were found, but they were not adequate to determine the exact species.

We reached the International Boundary in the midafternoon of 11 April, and San Francisco the following afternoon. The number of reptiles captured had been disappointingly low, the snails good in some places, scattered in others and absent in a high percentage of the spots tested. Plants had been seen at nearly every stop and turn, but most of the species had been collected several times before, so the take was by no means large. However, we had seen a part of the arid waist of the Peninsula of Baja California that was new to us, and our collections helped to fill gaps that had existed in the documented distribution of a number of organisms. The expedition had been well worth the time, energy, and money expended.

APPENDIX

Collecting Stations of The Vizcaíño Desert Expedition

25 March to 12 April 1961

Collecting localities are sometimes difficult to pinpoint a few years after the original field work was done. Rapid changes are being made, and planned, in construction of roads, development of agricultural ventures, and exploitation of mineral resources in Baja California. In order to reduce the probability of future puzzles we present herewith a list of the collecting stations at which any member of the party obtained specimens during our 1961 expedition.

In the field, three separate sets of collection notes were kept, one dealing with the reptiles and amphibians, one for invertebrates (mainly for insects, snails, centipedes, and scorpions, plus a few marine invertebrates), and one covering the plants. All three sets are coordinated in this list, with the following abbreviations applicable: VE-1, etc., the chronologically arranged Vizcaíño Expedition master number; (H-76), the field number applied to herpetological sites or collection localities; (S-4), etc., field number applying to collection stations arranged by the malacologist, but covering all collections of invertebrates; M = malacological collection; H = herpetological collection; I =Insect (or other invertebrate) collection; P = plant collection.